PCT/JP2003/003548

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 903054	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/JP2003/003548	International filing date (*day/month/year*) 24 March 2003 (24.03.2003)	Priority date (*day/month/year*) 31 October 2002 (31.10.2002)
International Patent Classification (IPC) or national classification and IPC F25B 9/00, B29C 59/02, 59/16		
Applicant SHARP KABUSHIKI KAISHA		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
13 November 2003 (13.11.2003)	16 August 2004 (16.08.2004)
Name and mailing address of the IPEA/JP Facsimile No.	Authorized officer Telephone No.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/JP2003/003548

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed

☒ the description:

pages 2-4,6-30, as originally filed
pages , filed with the demand
pages 1,5,31, filed with the letter of 28 April 2004 (28.04.2004)

☒ the claims:

pages 8,10,11, as originally filed
pages 2,5,9,17, as amended (together with any statement under Article 19
pages , filed with the demand
pages , filed with the letter of

☒ the drawings:

pages 1-19, as originally filed
pages , filed with the demand
pages , filed with the letter of

☐ the sequence listing part of the description:

pages , as originally filed
pages , filed with the demand
pages , filed with the letter of

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

☐ the description, pages _____
☒ the claims, Nos. 1,3,4,6,7,12-16,18,19
☐ the drawings, sheets/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rule 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/JP03/03548

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	2, 5, 8-11, 17	YES
	Claims		NO
Inventive step (IS)	Claims	2, 5, 8-11, 17	YES
	Claims		NO
Industrial applicability (IA)	Claims	2, 5, 8-11, 17	YES
	Claims		NO

2. Citations and explanations

Claims 2, 5, 8-11, 17

None of the documents cited in the ISR describes the inventions relating to claims 2, 5, 8-11 and 17, nor are these obvious to a person skilled in the art.

DESCRIPTION

Regenerator, Method and Apparatus for Manufacturing Regenerator, and Stirling Refrigerator

Technical Field

The present invention relates to a regenerator formed by stacking a film-shaped resin material, a method and apparatus for manufacturing the regenerator, and a Stirling refrigerator provided with the regenerator.

Background Art

In recent years, Stirling engines have attracted attention from the standpoint of energy saving, environmental protection and the like. The Stirling engine is an external combustion engine that realizes a reversible, Stirling cycle utilizing an external heat source, which is advantageous in terms of energy saving and low pollution compared to the internal combustion engine that requires fuel excellent in inflammability as well as ignitionability such as gasoline.

A Stirling refrigerator is widely known as an application of the Stirling engine. The Stirling refrigerator uses a reversed Stirling cycle to generate cryogenic temperatures. Hereinafter, a structure of the Stirling refrigerator is explained with reference to the drawings.

As shown in Fig. 22, a Stirling refrigerator includes a cylinder 20 having an interior filled with an inactive gas such as hydrogen or helium as the working gas. Fitted in cylinder 20 are a piston 27 and a displacer 26, which divide the space within cylinder 20 into a compression space 28 and an expansion space 29. Piston 27 is driven by a linear motor 30. Piston 27, connected via a spring 32 to a body casing 23, periodically moves in cylinder 20 in a sinusoidal manner. Displacer 26, receiving the force of the sinusoidal movement of piston 27, reciprocates in cylinder 20. Since

in an outer case 33 mounted in advance to a case body 23. In this case, regenerator 15 may be arranged such that the axis line of wound resin film 8 is approximately parallel to the flow direction of the working gas, to enable the working gas to flow within the flow passage formed by the dimples as described above. Further, a heat absorber 21 is attached from above, so that a closed thermal circuit is formed in the Stirling refrigerator, with regenerator 15 secured in place.

In the case where the dimples are formed by bonding spacers to the surface of the resin film, the work is very burdensome. Generally, very fine spacers are bonded to the surface of the resin film in order to secure a greater heat transfer area with the working gas within the regenerator. This involves various problems that the bonding work in itself is troublesome, that accuracy of bonding position is low, that dust or dirt may be introduced during the bonding work, and that the use of an adhesive cannot guarantee high reliability over a long period of time.

In the case where the dimples are formed by silkscreen printing on the surface of the resin film, the manufacturing cost increases due to the necessity of additional equipment for printing, drying and others. It is also very difficult to control the position, size, shape and the like of the dimples with the silkscreen printing.

Further, conventional regenerators formed by winding resin film have dimples always regularly arranged on the surface of the resin film. This disadvantageously simplifies the flow of the working gas through the regenerator, making it difficult to obtain high heat exchange efficiency.

Disclosure of the Invention

An object of the present invention is to provide a regenerator that is highly reliable, easy and inexpensive to manufacture, and exhibits high heat exchange efficiency, a method and apparatus for manufacturing the regenerator, and a Stirling refrigerator provided with the regenerator.

Another object of the present invention is to provide a method and apparatus for

manufacturing a regenerator that ensure an increased degree of design freedom of dimples to be formed on a resin film constituting the regenerator, and allow the dimples to be formed with good reproducibility and with a high degree of accuracy.

A regenerator according to an aspect of the present invention is disposed on a flow passage for a working gas, and is formed by stacking a film-shaped resin member in a direction crossing a flow direction of the working gas. The resin member has a dimple formed by subjecting its surface to plastic deformation. The dimple provides a gap between layers of the stacked resin member.

As such, the dimple is formed directly by causing the surface of the film-shaped resin member to undergo plastic deformation. Accordingly, the regenerator can be manufactured with ease and at low cost.

In the regenerator according to the aspect of the present invention, for example, the dimple preferably has an opening on its tip.

As the opening is formed at the tip of the dimple, the flow passage for the working gas flowing within the regenerator is disturbed, so that heat exchange efficiency can be improved.

In the regenerator according to the aspect of the present invention, for example, the dimple is preferably formed by performing stamping on the surface of the resin member.

By conducting the stamping for forming the dimple on the surface of the resin member, the surface of the resin member undergoes plastic deformation quite easily to form the dimple. Further, forming the dimple by stamping can increase the degree of design freedom of the dimple and also allows formation of the dimple with good reproducibility. Accordingly, it is possible to provide a regenerator having high heat exchange efficiency.

In the regenerator according to the aspect of the present invention, for example, the dimple is preferably formed by irradiating the surface of the resin member with a laser beam.

efficiency, a method and apparatus for manufacturing the regenerator, and a Stirling refrigerator provided with the regenerator.

Further, according to the present invention, it is possible to provide a method and apparatus for manufacturing a regenerator that ensure an increased degree of design freedom of dimples to be formed on a resin film constituting the regenerator and allow the dimples to be formed with good reproducibility and with a high degree of accuracy.

CLAIMS

1. A regenerator disposed on a flow passage for a working gas, formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of the working gas,

said resin member (8) including a dimple (10) formed by subjecting a surface of said resin member to plastic deformation, and

said dimple (10) providing a gap (9) between layers of said stacked resin member (8).

2. The regenerator according to claim 1, wherein said dimple (10) has an opening (10b1) on its tip.

3. The regenerator according to claim 1, wherein said dimple (10) is formed by performing stamping on the surface of said resin member (8).

4. The regenerator according to claim 1, wherein said dimple (10) is formed by irradiating the surface of said resin member (8) with a laser beam.

5. The regenerator according to claim 1, wherein on the surface of said resin member (8), the dimple (10) in a prescribed region is adjusted to have a height different from a height of the dimple (10) in another region.

6. The regenerator according to claim 1, wherein on the surface of said resin member (8), the number of the dimples (10) per unit area is adjusted to differ in accordance with a position on the surface of said resin member (8).

7. A regenerator disposed on a flow passage for a working gas flowing

between a compression space (28) and an expansion space (29) of a Stirling refrigerator, formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of said working gas,

said resin member (8) having a plurality of dimples (10) on its surface,

said plurality of dimples (10) providing a gap (9) between layers of said stacked resin member (8), and

on the surface of said resin member (8), the dimple (10) in a prescribed region being adjusted to have a height that is different from a height of the dimple (10) in another region.

8. A regenerator disposed on a flow passage for a working gas flowing between a compression space (28) and an expansion space (29) of a Stirling refrigerator, formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of said working gas,

said resin member (8) having a plurality of dimples (10) on its surface,

said plurality of dimples (10) providing a gap (9) between layers of said stacked resin member (8), and

on the surface of said resin member (8), the number of the dimples (10) per unit area being increased as the distance from said expansion space (29) decreases, compared to the side of said compression space (28).

9. A Stirling refrigerator, provided with a regenerator that is disposed on a flow passage for a working gas and is formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of the working gas,

said resin member (8) including a dimple (10) formed by subjecting a surface of said resin member to plastic deformation, and

said dimple (10) providing a gap (9) between layers of said stacked resin member (8).

10. A Stirling refrigerator, provided with a regenerator that is disposed on a flow passage for a working gas flowing between a compression space (28) and an expansion space (29) and is formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of said working gas,

said resin member (8) having a plurality of dimples (10) on its surface,

said plurality of dimples (10) providing a gap (9) between layers of said stacked resin member (8), and

on the surface of said resin member (8), the dimple (10) in a prescribed region being adjusted to have a height that is different from a height of the dimple (10) in another region.

11. A Stirling refrigerator, provided with a regenerator that is disposed on a flow passage for a working gas flowing between a compression space (28) and an expansion space (29) and is formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of said working gas,

said resin member (8) having a plurality of dimples (10) on its surface,

said plurality of dimples (10) providing a gap (9) between layers of said stacked resin member (8), and

on the surface of said resin member (8), the number of said dimples (10) per unit area being increased as the distance from said expansion space (29) decreases, compared to the side of said compression space (28).

12. A manufacturing method of a regenerator that is disposed on a flow passage for a working gas and is formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of the working gas, comprising:

the dimple formation step of subjecting a surface of said resin member (8) to plastic deformation to form a dimple (10) for providing a gap (9) between layers of said

resin member (8) to be stacked; and

the stacking step of stacking said resin member (8) having the dimple (10) formed thereon.

13. The manufacturing method of a regenerator according to claim 12, wherein said dimple formation step includes the stamping step of performing stamping on the surface of said resin member (8) using a stamping die (102) to form said dimple (10).

14. The manufacturing method of a regenerator according to claim 12, wherein said dimple formation step includes the laser beam irradiation step of irradiating the surface of said resin member (8) with a laser beam (203) to form said dimple (10).

15. The manufacturing method of a regenerator according to claim 14, wherein a spot diameter, irradiation power and irradiation time of said laser beam (203) for irradiating said resin member (8) are controlled to adjust a formed position, size and shape of said dimple (10) on the surface of said resin member (8).

16. A manufacturing apparatus of a regenerator, forming a dimple (10) on a surface of a film-shaped resin member (8), comprising:

sending means (113) for sending said film-shaped resin member (8) in one direction; and

dimple formation means (101, 201) for subjecting the surface of said film-shaped resin member (8) to plastic deformation to form said dimple (10).

17. The manufacturing apparatus of a regenerator according to claim 16, comprising height adjustment means (114), having a pair of pinching members (114a, 114b) spaced apart from each other by a predetermined distance and arranged to face each other in a direction crossing the surface of said film-shaped resin member (8) on a

downstream side of said dimple formation means (101, 201), for adjusting a height of said dimple (10) formed by said dimple formation means (101, 201) by letting said film-shaped resin member (8) pass through a gap between said pinching members (114a, 114b).

18. The manufacturing apparatus of a regenerator according to claim 16, wherein said dimple formation means is comprised of a stamping machine (101) that includes a stamping die (102) and a stage (104) positioned on the opposite side of said stamping die (102) via said film-shaped resin member (8) being sent in the one direction.

19. The manufacturing apparatus of a regenerator according to claim 16, wherein said dimple formation means is comprised of laser beam irradiation means (201) for irradiation with a laser beam (203).

AMENDED CLAIMS

[received by the International Bureau on October 22, 2003 (22.10.03);
original claims 2, 4, 5, 9, and 17 amended; claims 1, 3, 6, 7, 12-16, 18, and 19 cancelled;
remaining claims unchanged (4 pages)]

CLAIMS

1. (cancelled)

2. (amended) A regenerator disposed on a flow passage for a working gas, formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of the working gas,

said resin member (8) including a projection (10) formed by subjecting a surface of said resin member to plastic deformation and having an opening (10b1) on its tip, and

said projection (10) providing a gap (9) between layers of said stacked resin member (8).

3. (cancelled)

4. (amended) A regenerator disposed on a flow passage for a working gas, formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of the working gas,

said resin member (8) including a projection (10) formed by subjecting a surface of said resin member to plastic deformation, and

said projection (10) being formed by irradiating the surface of said resin member (8) with a laser beam.

5. (amended) A regenerator disposed on a flow passage for a working gas, formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of the working gas,

said resin member (8) including a projection (10) formed by subjecting a surface of said resin member to plastic deformation, and

on the surface of said resin member (8), the projection (10) in a prescribed

region being adjusted to have a height different from a height of the projection (10) in another region.

6. (cancelled)

7. (cancelled)

8. A regenerator disposed on a flow passage for a working gas flowing between a compression space (28) and an expansion space (29) of a Stirling refrigerator, formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of said working gas,

said resin member (8) having a plurality of projections (10) on its surface,

said plurality of projections (10) providing a gap (9) between layers of said stacked resin member (8), and

on the surface of said resin member (8), the number of the projections (10) per unit area being increased as the distance from said expansion space (29) decreases, compared to the side of said compression space (28).

9. (amended) A Stirling refrigerator, provided with a regenerator that is disposed on a flow passage for a working gas and is formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of the working gas,

said resin member (8) including a projection (10) formed by subjecting a surface of said resin member to plastic deformation and having an opening (10b1) on its tip, and

said projection (10) providing a gap (9) between layers of said stacked resin member (8).

10. A Stirling refrigerator, provided with a regenerator that is disposed on a flow passage for a working gas flowing between a compression space (28) and an

expansion space (29) and is formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of said working gas,

said resin member (8) having a plurality of projections (10) on its surface,

said plurality of projections (10) providing a gap (9) between layers of said stacked resin member (8), and

on the surface of said resin member (8), the projection (10) in a prescribed region being adjusted to have a height that is different from a height of the projection (10) in another region.

11. A Stirling refrigerator, provided with a regenerator that is disposed on a flow passage for a working gas flowing between a compression space (28) and an expansion space (29) and is formed by stacking a film-shaped resin member (8) in a direction crossing a flow direction of said working gas,

said resin member (8) having a plurality of projections (10) on its surface,

said plurality of projections (10) providing a gap (9) between layers of said stacked resin member (8), and

on the surface of said resin member (8), the number of said projections (10) per unit area being increased as the distance from said expansion space (29) decreases, compared to the side of said compression space (28).

12. (cancelled)

13. (cancelled)

14. (cancelled)

15. (cancelled)

AMENDED CLAIMS

[received by the International Bureau on October 22, 2003 (22.10.03); original claims 2, 4, 5, 9, and 17 amended; claims 1, 3, 6, 7, 12-16, 18, and 19 cancelled; remaining claims unchanged (4 pages)]

16. (cancelled)

17. (amended) A manufacturing apparatus of a regenerator, forming a projection (10) on a surface of a film-shaped resin member (8), comprising:

sending means (113) for sending said film-shaped resin member (8) in one direction;

projection formation means (101, 201) for subjecting the surface of said film-shaped resin member (8) to plastic deformation to form said projection (10); and

height adjustment means (114), having a pair of pinching members (114a, 114b) spaced apart from each other by a predetermined distance and arranged to face each other in a direction crossing the surface of said film-shaped resin member (8) on a downstream side of said projection formation means (101, 201), for adjusting a height of said projection (10) formed by said projection formation means (101, 201) by letting said film-shaped resin member (8) pass through a gap between said pinching members (114a, 114b).

18. (cancelled)

19. (cancelled)

特　許　協　力　条　約

PCT

国際予備審査報告

（法第１２条、法施行規則第56条）
〔ＰＣＴ３６条及びＰＣＴ規則70〕

出願人又は代理人の書類記号　９０３０５４	今後の手続きについては、国際予備審査報告の送付通知（様式ＰＣＴ／ＩＰＥＡ／４１６）を参照すること。	
国際出願番号 ＰＣＴ／ＪＰ０３／０３５４８	国際出願日（日.月.年）　２４．０３．２００３	優先日（日.月.年）　３１．１０．２００２
国際特許分類（ＩＰＣ）Ｉｎｔ．Ｃｌ’ Ｆ２５Ｂ９／００　Ｂ２９Ｃ５９／０２　Ｂ２９Ｃ５９／１６		
出願人（氏名又は名称） シャープ株式会社		

１．　国際予備審査機関が作成したこの国際予備審査報告を法施行規則第57条（ＰＣＴ３６条）の規定に従い送付する。

２．　この国際予備審査報告は、この表紙を含めて全部で　3　ページからなる。

☒ この国際予備審査報告には、附属書類、つまり補正されて、この報告の基礎とされた及び／又はこの国際予備審査機関に対してした訂正を含む明細書、請求の範囲及び／又は図面も添付されている。
（ＰＣＴ規則70.16及びＰＣＴ実施細則第６０７号参照）
この附属書類は、全部で　6　ページである。

３．　この国際予備審査報告は、次の内容を含む。

Ⅰ　☒　国際予備審査報告の基礎

Ⅱ　☐　優先権

Ⅲ　☐　新規性、進歩性又は産業上の利用可能性についての国際予備審査報告の不作成

Ⅳ　☐　発明の単一性の欠如

Ⅴ　☒　ＰＣＴ３５条(2)に規定する新規性、進歩性又は産業上の利用可能性についての見解、それを裏付けるための文献及び説明

Ⅵ　☐　ある種の引用文献

Ⅶ　☐　国際出願の不備

Ⅷ　☐　国際出願に対する意見

国際予備審査の請求書を受理した日　１３．１１．２００３	国際予備審査報告を作成した日　１６．０８．２００４
名称及びあて先 日本国特許庁（ＩＰＥＡ／ＪＰ） 郵便番号１００－８９１５ 東京都千代田区霞が関三丁目４番３号	特許庁審査官（権限のある職員）　３Ｍ　７６１６ 清水　富夫 電話番号　０３－３５８１－１１０１　内線　３３７６

様式ＰＣＴ／ＩＰＥＡ／４０９（表紙）（１９９８年７月）

国際予備審査報告

国際出願番号　ＰＣＴ／ＪＰ０３／０３５４８

Ⅰ．　国際予備審査報告の基礎

1．　この国際予備審査報告は下記の出願書類に基づいて作成された。（法第６条（ＰＣＴ１４条）の規定に基づく命令に応答するために提出された差し替え用紙は、この報告書において「出願時」とし、本報告書には添付しない。ＰＣＴ規則70.16, 70.17）

☐ 出願時の国際出願書類

☒ 明細書　第 2－4，6－30 ページ、出願時に提出されたもの
明細書　第 ＿＿＿＿＿＿ ページ、国際予備審査の請求書と共に提出されたもの
明細書　第 1，5，31 ページ、28．04．2004 付の書簡と共に提出されたもの

☒ 請求の範囲　第 8，10，11 項、出願時に提出されたもの
請求の範囲　第 2，5，9，17 項、ＰＣＴ１９条の規定に基づき補正されたもの
請求の範囲　第 ＿＿＿＿＿＿ 項、国際予備審査の請求書と共に提出されたもの
請求の範囲　第 ＿＿＿＿＿＿ 項、＿＿＿＿＿＿ 付の書簡と共に提出されたもの

☒ 図面　第 1－19 ページ／図、出願時に提出されたもの
図面　第 ＿＿＿＿＿＿ ページ／図、国際予備審査の請求書と共に提出されたもの
図面　第 ＿＿＿＿＿＿ ページ／図、＿＿＿＿＿＿ 付の書簡と共に提出されたもの

☐ 明細書の配列表の部分　第 ＿＿＿＿＿＿ ページ、出願時に提出されたもの
明細書の配列表の部分　第 ＿＿＿＿＿＿ ページ、国際予備審査の請求書と共に提出されたもの
明細書の配列表の部分　第 ＿＿＿＿＿＿ ページ、＿＿＿＿＿＿ 付の書簡と共に提出されたもの

2．　上記の出願書類の言語は、下記に示す場合を除くほか、この国際出願の言語である。

上記の書類は、下記の言語である＿＿＿＿＿＿ 語である。

☐ 国際調査のために提出されたＰＣＴ規則23.1(b)にいう翻訳文の言語
☐ ＰＣＴ規則48.3(b)にいう国際公開の言語
☐ 国際予備審査のために提出されたＰＣＴ規則55.2または55.3にいう翻訳文の言語

3．　この国際出願は、ヌクレオチド又はアミノ酸配列を含んでおり、次の配列表に基づき国際予備審査報告を行った。

☐ この国際出願に含まれる書面による配列表
☐ この国際出願と共に提出された磁気ディスクによる配列表
☐ 出願後に、この国際予備審査（または調査）機関に提出された書面による配列表
☐ 出願後に、この国際予備審査（または調査）機関に提出された磁気ディスクによる配列表
☐ 出願後に提出した書面による配列表が出願時における国際出願の開示の範囲を超える事項を含まない旨の陳述書の提出があった
☐ 書面による配列表に記載した配列と磁気ディスクによる配列表に記録した配列が同一である旨の陳述書の提出があった。

4．　補正により、下記の書類が削除された。
☐ 明細書　第 ＿＿＿＿＿＿ ページ
☒ 請求の範囲　第 1，3，4，6，7，12－16，18，19 項
☐ 図面　図面の第 ＿＿＿＿＿＿ ページ／図

5．☐ この国際予備審査報告は、補充欄に示したように、補正が出願時における開示の範囲を超えてされたものと認められるので、その補正がされなかったものとして作成した。（ＰＣＴ規則70.2(c)　この補正を含む差し替え用紙は上記１．における判断の際に考慮しなければならず、本報告に添付する。）

国際予備審査報告

国際出願番号　ＰＣＴ／ＪＰ０３／０３５４８

Ⅴ．　新規性、進歩性又は産業上の利用可能性についての法第１２条（ＰＣＴ３５条(2)）に定める見解、それを裏付ける文献及び説明

１．　見解

新規性（N）	請求の範囲	２，５，８－１１，１７	有
	請求の範囲		無
進歩性（ＩＳ）	請求の範囲	２，５，８－１１，１７	有
	請求の範囲		無
産業上の利用可能性（ＩＡ）	請求の範囲	２，５，８－１１，１７	有
	請求の範囲		無

２．　文献及び説明（ＰＣＴ規則70.7）

請求項２，５，８－１１，１７
　請求項２，５，８－１１，１７に係る発明は、国際調査報告で引用されたいずれの文献にも記載されておらず、当業者にとって自明なものでもない。

明細書

再生器、再生器の製造装置およびスターリング冷凍機

技術分野

本発明は、フィルム状の樹脂部材を積層してなる再生器、その再生器の製造装置およびその再生器を備えたスターリング冷凍機に関する。

背景技術

近年、省エネルギーや環境問題などの見地から、スターリング機関が注目を浴びている。スターリング機関は、外部の熱源を利用して可逆サイクルであるスターリングサイクルを実現する外燃機関であり、ガソリンなどの引火性や着火性に優れた燃料を必要とする内燃機関などに比べ、省エネルギーで低公害であるという優れた長所を有する熱機関である。

このスターリング機関の応用例として、スターリング冷凍機が広く知られている。このスターリング冷凍機は、逆スターリングサイクルを用いて極低温を発生させる冷凍機である。以下、図を参照してスターリング冷凍機の構造について説明する。

図２２に示すように、スターリング冷凍機は、水素やヘリウムなどの不活性ガスが作動ガスとして内部に充填されたシリンダ２０を備えている。このシリンダ２０内には、ピストン２７およびディスプレーサ２６が嵌挿されており、これらによってシリンダ２０内の空間が圧縮室２８と膨張室２９とに区画されている。ピストン２７はリニアモータ３０によって駆動されるが、バネ３２によって本体ケーシング２３に接続されているため、シリンダ２０内を周期的に正弦運動する。また、ディスプレーサ２６は、ピストン２７の正弦運動の力を受けてシリンダ２０内を往復動するが、ピストン２７と同様にバネ３１によって本体ケーシング２３に接続されているため、周期的な正弦運動をとることになる。このピストン２７の正弦運動とディスプレーサ２６の正弦運動とは、定常運転時において同じ周

サは、再生器内において作動ガスとの伝熱面積をより大きく確保するために微細なものが用いられる。このため、貼り付け作業が非常に煩雑となっていた。また、貼り付け位置精度が低い点や貼り付け時にゴミを巻き込んでしまうおそれがある点、接着剤を使用するために長期にわたって高い信頼性を維持できない点など、種々の問題点も有していた。

また、シルク印刷を施すことにより、樹脂フィルムの表面に突起部を形成した場合には、印刷設備や乾燥設備などを別途必要とするため、製造コストが増大する問題があった。また、シルク印刷において、突起部の位置や大きさ、形状などを制御することは非常に困難であるという問題も有していた。

さらに、樹脂フィルムを巻き回して形成した再生器にあっては、従来、樹脂フィルムの表面に規則的に突起部が配置されたものしか存在せず、再生器として利用した場合に再生器内を流動する作動ガスの流れが単純化してしまい、高い熱交換効率が得られない問題も有していた。

発明の開示

本発明の一の目的は、高信頼性で簡便かつ安価に製造が可能な高熱交換効率の再生器、その再生器の製造装置およびその再生器を備えたスターリング冷凍機を提供することにある。

また、他の目的は、再生器を構成する樹脂フィルムに形成される突起部の設計自由度が高められ、かつ再現性よく高精度に突起部が形成可能な再生器の製造装置を提供することにある。

本発明のある局面に従う再生器は、作動ガスの流路上に配設され、作動ガスの流動方向と交差する方向にフィルム状の樹脂部材を積層してなる。樹脂部材は、その表面を塑性変形させることによって形成された突起部を備えており、この突起部によって積層される樹脂部材同士が間隙部を有している。

このように、直接フィルム状の樹脂部材の表面を塑性変形させることによって突起部を形成することにより、簡便かつ安価に再生器を製作することが可能になる。

上記本発明のある局面に従う再生器にあっては、たとえば、突起部がその頂点

器、その再生器の製造装置およびその再生器を備えたスターリング冷凍機を提供することが可能になる。

また、本発明によれば、再生器を構成する樹脂フィルムに形成される突起部の設計自由度が高められ、かつ再現性よく高精度に突起部が形成可能な再生器の製造装置を提供することが可能になる。

請求の範囲

1．

2．作動ガスの流路上に配設され、作動ガスの流動方向と交差する方向にフィルム状の樹脂部材（８）を積層してなる再生器であって、

前記樹脂部材（８）は、その表面を塑性変形させることによって形成され、頂点に開口部（１０ｂ１）を有する突起部（１０）を備え、

前記突起部（１０）によって前記積層される樹脂部材（８）同士が間隙部（９）を有している、再生器。

3．

4．（削除）

5．作動ガスの流路上に配設され、作動ガスの流動方向と交差する方向にフィルム状の樹脂部材（８）を積層してなる再生器であって、

前記樹脂部材（８）は、その表面を塑性変形させることによって形成された突起部（１０）を備え、

前記樹脂部材（８）の表面において、所定領域の突起部（１０）の高さが、他の領域の突起部（１０）の高さと異なるように調節されている、再生器。

6．

7．

8．スターリング冷凍機の圧縮室（２８）と膨張室（２９）との間を流動する作動ガスの流路上に配設され、前記作動ガスの流動方向と交差する方向にフィルム状の樹脂部材（８）を積層してなる再生器であって、

前記樹脂部材（８）は、その表面に複数の突起部（１０）を備え、

前記複数の突起部（１０）によって前記積層される樹脂部材（８）同士が間隙

部（９）を有しており、

前記樹脂部材（８）の表面において、単位面積当たりの突起部（１０）の数が、前記圧縮室（２８）側に比べて前記膨張室（２９）側に近付くほど多くなっている、再生器。

９．（補正後）作動ガスの流路上に配設され、作動ガスの流動方向と交差する方向にフィルム状の樹脂部材（８）を積層してなる再生器を備えたスターリング冷凍機であって、

前記樹脂部材（８）は、その表面を塑性変形させることによって形成され、頂点に開口部（１０ｂ１）を有する突起部（１０）を備え、

前記突起部（１０）によって前記積層される樹脂部材（８）同士が間隙部（９）を有している、スターリング冷凍機。

１０．圧縮室（２８）と膨張室（２９）との間を流動する作動ガスの流路上に配設され、前記作動ガスの流動方向と交差する方向にフィルム状の樹脂部材（８）を積層してなる再生器を備えたスターリング冷凍機であって、

前記樹脂部材（８）は、その表面に複数の突起部（１０）を備え、

前記複数の突起部（１０）によって前記積層される樹脂部材（８）同士が間隙部（９）を有しており、

前記樹脂部材（８）の表面において、所定領域の突起部（１０）の高さが、他の領域の突起部（１０）の高さと異なるように調節されている、スターリング冷凍機。

１１．圧縮室（２８）と膨張室（２９）との間を流動する作動ガスの流路上に配設され、前記作動ガスの流動方向と交差する方向にフィルム状の樹脂部材（８）を積層してなる再生器を備えたスターリング冷凍機であって、

前記樹脂部材（８）は、その表面に複数の突起部（１０）を備え、

前記複数の突起部（１０）によって前記積層される樹脂部材（８）同士が間隙部（９）を有しており、

前記樹脂部材（８）の表面において、単位面積当たりの突起部（１０）の数が、前記圧縮室（２８）側に比べて前記膨張室（２９）側に近付くほど多くなっている、スターリング冷凍機。

１２．（削除）

１３．（削除）

１４．（削除）

１５．（削除）

１６．（削除）

１７．（補正後）フィルム状の樹脂部材（８）の表面に突起部（１０）を形成する再生器の製造装置であって、

前記フィルム状の樹脂部材（８）を一方向に送り出す送出手段（１１３）と、

前記フィルム状の樹脂部材（８）の表面を塑性変形させることにより、前記突起部（１０）を形成する突起部形成手段（１０１，２０１）と、

前記フィルム状の樹脂部材（８）の表面と交差する方向に対向して位置し、所定の距離を隔てて離間するように配置された一対の挟持部（１１４ａ，１１４ｂ）を前記突起部形成手段（１０１，２０１）の下流側に有し、前記挟持部（１１４ａ，１１４ｂ）の間の隙間に前記フィルム状の樹脂部材（８）を通すことにより、前記突起部形成手段（１０１，２０１）によって形成された前記突起部（１０）の高さを調節する高さ調節手段（１１４）とを備える、再生器の製造装置。

１８．（削除）

１９．（削除）